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ABSTRACT

Demographic data are used in this report to present information about infant mortality in more- and less-developed countries. One chapter is devoted to rising infant mortality rates in developed countries, which defy the typical post-World War II pattern. Severe economic conditions are linked to this increase. Direct causes of infant deaths are identified as birth defects, malnutrition, and disease. Infectious and parasitic diseases cause deaths frequently preventable by vaccination or proper sanitation. Not considered an outright killer of infants, malnutrition is seen as an accessory to the crime. Indirect causes of infant mortality are traced to social and physical environments. Poor medical care, ignorance, and low income are three factors in infant mortality that are aspects of the social environment; poor sanitation and polluted water are the major factors included in the physical environment. The total number of children a woman has borne, although not clearly linked to infant mortality, is also considered important. A three-stage endeavor to reduce infant mortality is discussed in terms of quality of life, medical interventions, and care of sick infants. (Author/DB)

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Infant Mortality and the Health of Societies

Kathleen Newland

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Introduction

No cold statistic expresses more eloquently the difference between a society of sufficiency and a society of deprivation than the infant mortality rate. It is usually expressed as the number of babies out of each thousand born alive who die before they reach the age of one. Among the most deprived people in the world, as many as 200 of every thousand live-born infants die before their first birthdays. At times of greater-than-usual crisis, the proportion goes even higher. By contrast, rates of fewer than 10 deaths per thousand live births have been achieved in wealthy and egalitarian societies. 5

The stark difference between the high and low ends of this range cannot be attributed solely to the effects of poverty and affluence. There are poor countries in which the infant mortality rate is quite low, and relatively rich ones in which it is high. Though not perfectly correlated with the average income, the number of children who die before they are one year old is closely related to the overall level of well-being in a country or region—so closely, in fact, that it is regarded as one of the most revealing measures of how well a society is meeting the needs of its people.

As a social indicator, the infant mortality rate illuminates much that a measurement of the gross national product (GNP) obscures. It is particularly sensitive to distributive issues. It reflects not simply per capita stocks of food, clean water, medical care, and so forth, but the actual availability of such amenities to all segments of a population. Deprivation among the people of a particular region, class, or ethnic group within a country may be masked by average income figures, but it is very likely to show up in infant mortality statistics.

High infant mortality is associated with certain social problems that may persist even in the face of rising per capita income: environmental contamination, lack of education, discrimination against women, poor health services, and so forth. A high or rising infant

I wish to thank Paige Tolbert for her assistance with the research for this paper.

6 mortality rate, or even one that fails to decline with income gains, is the sign of a development process gone astray. Conversely, a rapidly declining rate may signify an improvement in social and environmental conditions that is disguised by slow growth of the GNP.

In searching out the explanation of infant deaths, two levels of analysis are needed: one to identify the immediate causes of death and another to examine the social, economic, or environmental conditions that make infants vulnerable to those immediate causes. The proximate cause of a baby's death may be sheer lack of food, a disease, a severe birth defect, extreme prematurity, or an injury. But behind most deaths from one of these there is likely to be a genealogy of hazard, in the form of low family income, lack of sanitation, ignorance, discrimination, crowding, high fertility, or exposure to toxic substances. Many of the direct and indirect causes of death in the very young interact, so that it is difficult to pinpoint a single fatal factor.

There is a sharp dichotomy between the patterns of infant mortality in countries with high and low rates. In countries with very low infant mortality rates, most babies who die do so within their first month of life as a result of low birth weight or congenital abnormalities. Indirect factors in the baby's environment play a lesser role during these first few weeks, though considerable study is now being given to elements in the parents' environment that may place newborns at risk. In countries where mortality among infants is high, however, environmental factors are paramount. Their importance declines with the infant mortality rate—which is of course what makes the statistic such a sensitive indicator of social welfare. Once moderate rates are attained, specific medical programs become more important in reducing them further.

Precisely because infant mortality is so closely tied to broad economic and social conditions and to the complex interactions between them, specific interventions designed to improve a baby's chances of survival may have a limited effect if they are pursued in isolation. The most decisive gains to be made in moving a country from high to

moderate infant mortality rates involve improvements in the direct causes of infant death—better sanitation, water supply, nutrition, access to fertility control and medical care, and education. Clearly, policies that accomplish these goals will confer great benefits on society as a whole. A reduction in the infant mortality rate therefore sends a double signal: not only has a major humanitarian goal been realized, but the general process of national development is moving in a healthy direction.

Levels and Trends of Infant Mortality

Under primitive physical conditions, between one-fifth and one-quarter of all babies can be expected to die. This was about the rate that prevailed in now-developed countries during the eighteenth century and, with some exceptions, for most of the nineteenth. It is also the rate still found in several regions and countries today—those where extreme poverty is combined with an almost complete lack of modern medical care or public health measures such as mass vaccination

In these circumstances infants have little protection against the buffeting of an environment in which hunger is a recurrent fact and infection an ever-present threat. The historical record shows that infant mortality rates in Europe during the nineteenth century fluctuated widely in response to crises such as wars, famines, epidemics, and other kinds of upheavals. The social turmoil of the Industrial Revolution was reflected in extraordinarily high death rates among the children of newly urbanized industrial workers: one Bavarian city recorded an infant mortality rate of 449 per thousand in 1870. Demographer Francine van de Walle observes: "The crowded nineteenth century cities were nests of infections, where epidemics spread fast. Hygiene and the quality of water were poor, sewage disposal systems almost nonexistent. Mothers spent long hours outside the home, infants were weaned early or, as in France, sent to be fed and, often, die in the neighboring countryside."[1]

8 Toward the turn of the century, infant mortality rates in the cities began to fall dramatically. The change came earlier in some parts of Europe, notably France and Scandinavia, but failed to reach other parts until after World War I. Yet generally, with the installation of modern water and sewer systems, with increases in the real income of the laboring classes, and with a better understanding of how diseases spread and how they can be controlled, survival rates among the very young showed a sharp and consistent upturn. By 1940, at least nine out of ten children in most European countries survived their first year of life.[2]

In most, though not all, of the advanced industrial countries, the period since World War II has witnessed a continuing steady decline of infant mortality rates. The age of antibiotics is also an age of lower fertility, widespread public health measures, and increasing sophistication and availability of medical care—all of which supplement the effects of an improved standard of living. In France, Switzerland, Japan, the Netherlands, and all of Scandinavia, fewer than 10 babies in a thousand die. In North America and most of the rest of Western Europe, the rate is between 10 and 20 per thousand. During the course of one century, infant mortality rates in the most advanced countries have been slashed to less than one-tenth their former levels.[3]

In the least developed countries today, however, infant mortality rates as high as any in history can still be found. During the seventies, there were only two countries on the entire African mainland that reported infant mortality rates lower than 100 per thousand. Rates closer to 200 were common, both in Africa and Asia.[4] Ironically, the most rapid progress in reducing infant mortality has, in recent years, come about in countries where it was already relatively low. Thus the disparity between the world's highest and lowest rates is probably greater now than ever before.

High infant mortality is often associated with poverty and low infant mortality with wealth, but the correlation, as indicated, is far from perfect. Poverty itself doesn't cause babies to die, nor does wealth

"Poverty itself
doesn't cause babies to die,
nor does wealth rescue them."

rescue them. The disposition of available resources is the real determining factor; a low national income can buy a lot of health if knowledge and organization are applied to the solution of widespread problems. Conversely, a high national income can be distributed and spent in a way that mires huge numbers of people in the backwaters of progress.

The inconsistency of the direct relationship between income and infant mortality is revealed by the variation in the rate of infant deaths among countries with similar incomes. (See Table 1.) The differences are most dramatic among the countries with the highest per capita incomes, where the infant mortality rate varies by a factor of 19. Oil-rich countries such as Libya and Qatar, with respective rates of 130 and 138 per thousand, have not yet managed to translate their new wealth into the physical and social benefits that enhance their children's chances of survival. Japan, with a per capita income roughly half that of Qatar's and only $500 more than Libya's, has only nine infant deaths for every thousand live births. At the other end of the income scale, the contrasts in infant death rates are less striking proportionately but more striking in absolute terms: the fivefold variance between Sri Lanka on the one hand and Niger on the other translates into a difference of more than 150 babies out of every thousand who die before their first birthdays.[5]

Observations that contradict the expected association between income and mortality can also be found within countries. Kerala, one of the poorest states in India, has one of the lowest infant mortality rates; at 55 per thousand it is less than half the national average. In the United States, Washington, D.C. has the worst survival rate for children under one year old of any major metropolitan area, although it also has one of the highest per capita incomes.[6] The coexistence of low infant mortality with poverty is an encouraging demonstration of the fact that decent health need not await universal affluence. But the persistence of high death rates among the very young even in wealthy surroundings should act as a red flag to policymakers signaling that beneath the surface of economic progress something is seriously wrong.

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Table 1: Infant Mortality Rates in Selected Countries, by Per Capita Income Class

Country	Infant Mortality Rate (deaths per thousand live births)	Per Capita Income (dollars)
High-Income Countries		
Sweden	7	10,540
Japan	8	7,700
United States	13	9,770
Kuwait	39	15,970
Libya	130	7,210
Qatar	138	15,050
High Middle-Income Countries		
Singapore	13	3,260
New Zealand	14	5,530
Israel	16	3,730
Trinidad & Tobago	24	3,010
USSR	36	3,710
Saudi Arabia	118	6,590
Gabon	178	3,370
Middle-Income Countries		
Jamaica	16	1,190
Cuba	19	1,270
Costa Rica	22	1,610
Romania	30	1,650
Malaysia	44	1,150
Brazil	84	1,510
Iraq	92	1,850
South Africa	97	1,580
Algeria	127	1,450
Ivory Coast	138	950

Measuring the level of infant mortality sounds much simpler than it is. Births and deaths are discrete events, not judgment calls—or are

Table 1, continued

Low Middle-Income Countries		
Guyana	46	560
El Salvador	53	640
Philippines	65	530
Nigeria	157	600
Congo	180	580
Angola	192	420
Low-Income Countries		
Sri Lanka	42	200
Madagascar	102	250
Tanzania	125	240
Haiti	130	240
Bangladesh	139	90
Afghanistan	185	160
Niger	200	240

Source: Data are for 1978 or 1979, or the latest available estimates; Population Reference Bureau, and income data from World Bank, *1980 Atlas.*

they? In fact, official definitions of a "live birth" do vary from country to country. In some, the newborn must breathe in order to be counted among the living; in others, any sign of life, however fleeting, will suffice. The Soviet Union does not record a birth until the infant has survived for a week. As vexing as such inconsistencies are to the demographer, they are the least of the problems encountered. Vital registration in many of the least developed countries is practically nonexistent. Births are commonly underreported even if there is a registration system. And of all deaths that occur, those least likely to be reported are the deaths of very young children. This is not exclusively a problem of poor and developing countries: a careful hospital survey in Georgia in the United States discovered that 21 percent of the deaths of infants less than four weeks old went unreported between 1974 and 1977. Most of the babies who died were from poor, disadvantaged, rural families—a description that fits most of the population of the Third World.[7]

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Under such circumstances, the work of demographers is more like that of detectives than statisticians. They must derive infant mortality rates from what little is known about a given population's age structure, fertility rate, sex ratio, known birth and death records, and so forth. Different methods of estimation produce different results. Current estimates of infant mortality in China, for example, range from 17 to 63 per thousand.[8] Typically, the countries with the highest rates have the least reliable data, making the areas with the most urgent problems the ones that are the most difficult to approach with any certainty.

When measuring the level of infant mortality is difficult, the problems of discerning a trend are compounded. Censuses are taken once every ten years at the most, methods of data collection may change from one measurement period to the next, and surveys are often poorly conducted. Some countries still have never measured their infant mortality rates at all, or have done so only once. So a large part of the data on trends in high-mortality countries is extremely tentative.

The picture that does emerge from the available data is mixed. There is little information for the period before 1950, but it is clear that infant mortality has dropped, in most countries, over the past two or three decades—even though it remains at extremely high levels in some areas. (See Table 2.) Some developing countries—particularly in the Caribbean and in East Asia—have experienced strong declines, while in most of Africa and South Asia infant death rates have been static. In Latin America, countries such as Costa Rica, Panama, and Paraguay made rapid strides in the sixties while Honduras, Bolivia, and Argentina showed no improvement. In short, it is difficult to generalize about the infant mortality pattern in the Third World since 1960.[9] But it is safe to say that it does not mirror the sudden plunge that Europe and North America experienced around the turn of the century. The patchy, start-and-stop record of infant mortality decline in developing countries testifies to the difficult circumstances in which they are attempting the breakthrough to prosperity.

"An infant mortality rate regarded as the lowest attainable before the year 2000 had already been reached in Sweden in 1980."

Table 2: Infant Mortality Rates in Selected Developing Countries, 1960 and 1978*

Country	1960	1978
	(deaths per thousand live births)	
Sri Lanka	55	49
Philippines	98	65
Egypt	109	85
Kenya	126	91
Honduras	130	118
Indonesia	159	120
Cameroon	172	157

*These figures may not agree with those in Table 1, which are taken from a different source.
Source: World Bank, *1981 World Development Report.*

Infant mortality statistics in the industrial world are relatively reliable and reveal a much more coherent pattern. Reconstructing the historical record is still tricky, but for the postwar period there is clear evidence of a sustained decline. Infant mortality rates that were typically in the mid to high twenties around 1960 have given way to rates in the low teens or even lower. By 1979, among the 24 member countries of the Organisation for Economic Co-operation and Development, only in Turkey and Portugal did more than 20 babies per thousand die, and in seven countries the figure was under 10 per thousand. An infant mortality rate of 7 per thousand, regarded as the lowest rate attainable before the year 2000 in one important analysis, had already been reached in Sweden in 1980.[10]

To bring the infant death rate down to 7 or even 15 per thousand requires a fair amount of medical heroism—chiefly the ability to save the lives of children who weigh less than 2,500 grams (about 5.5 pounds) at birth. Medical technology has advanced by leaps and bounds in its ability to keep even the smallest babies alive. In the United States in 1960, three out of four infants who weighed less than 1,500 grams at birth died, whereas in 1980 two out of three survived. Even babies of birth weights below 1,000 grams (only 2.5

pounds) now have nearly a fifty-fifty chance of survival.[11] Pushing the infant mortality rate below 7 per thousand will mean crossing even farther frontiers in medical care—to save still more very small babies and even to begin treating threatened fetuses in the womb.

It will be many decades before such sophisticated care is available worldwide—if it ever is. Furthermore, it would be a tragic waste of resources to invest money and talent in very expensive, advanced technology in settings where most babies who die succumb to preventable or easily treated diseases. The World Health Organization calculates that, with a judicious application of existing resources, every country could achieve an infant mortality rate of 50 per thousand or less by the year 2000. Considering that the world average is currently 97 per thousand, and that the average for developing countries is approximately 109, universal attainment of a 50-per-thousand rate within 20 years would represent an impressive accomplishment.[12]

Disturbing Signs of Stress: Rising Infant Mortality Rates

Perhaps the most interesting and revealing trends in infant mortality are those in the few areas where the rates have been rising, in defiance of the typical postwar pattern. These increases are particularly disturbing because they are not the products of wars or natural disasters. Current measures of infant mortality are not available from regions affected by major catastrophes, such as Somalia, Cambodia, and Afghanistan. All of these would undoubtedly show increases in infant mortality brought about by drought, flood, war, and vast refugee-producing civil conflicts. During the 1971 war for independence in Bangladesh, for example, the death rate of infants between 1 and 11 months old increased by 46 percent over the average of the previous three years.[13] Usually, however, the same conditions that raise infant mortality in areas of acute crisis also disrupt the measurement of vital statistics. Most specific increases in infant mortality that have recently been observed arise from quite different circumstances: slow, long-term accretions of social and economic stresses.

In the United States, the city of Washington, D.C. recorded a 10 percent increase in its infant mortality rate in a single year, from 22.2 deaths per thousand births in 1979 to 24.6 per thousand in 1980. The major factors responsible for the high rate were social ones. An increasing proportion of births in the city were to poor, young, unmarried mothers who because of inability to pay, ignorance, inertia, or logistical difficulties failed to get adequate prenatal care. The babies of these disadvantaged women were likely to suffer complications relating to poor nutrition, drug abuse, and untreated infections. As a result, the city's incidence of babies of very low birth weight was three times the U.S. norm, and its infant mortality rate was about twice the national average.[14]

Washington, D.C. is one of the richest cities in the United States, but the average income figures conceal the existence of a substantial underclass of poor and disadvantaged families. A rising infant mortality rate thus signals the entrenchment of a dual society. A similar problem on a far grander scale afflicts Brazil, one of the few fast-growing, middle-income countries where a rise in infant mortality has been documented. The combined rate for the Brazilian state capitals rose from 103 per thousand in 1961 to 109 in 1970. During this period, the wealthiest 3.5 percent of the working population increased their share of national earnings from one-quarter to one-third of the total, while the share earned by the poorest 43 percent of workers fell from 11 to 8 percent. The purchasing power of the minimum wage fell by 30 percent, while the price of staple foods rose. Impoverished people from the rural areas fled into the increasingly crowded industrial centers, which had neither housing, health services, water, nor waste disposal systems to accommodate them. The effect of all this was most dramatic in São Paulo: the infant mortality rate rose from 63 in 1961, to 90 in 1970, and then to 95 in 1973.[15]

Sri Lanka—noted for its remarkable achievements in bringing mortality down to levels typical of countries with far higher incomes—in the early seventies saw a reversal of a 30-year decline in its infant mortality rate. Between 1971 and 1974, the rate rose steadily from 43 to 48 per thousand. These years were economically difficult ones for Sri

Lanka. Its terms of trade worsened by 23 percent, as world oil prices surged while prices declined for its major exports: tea, rubber, and coconut. At the same time, food production was hampered by drought. Even the country's extensive social welfare system may have begun to backfire by the early seventies. With massive subsidies for the consumption of rice, wheat, sugar, and other commodities, and various other welfare programs, the system soaked up as much as one-third of the government budget, leaving little for productive investment. High inflation and unemployment followed.[16]

All these economic strains may have worked their way down to the level of the family budget, there to push some vulnerable infants beyond the margin of survival. The economic disarray in Sri Lanka helped to precipitate a change of government in 1977. The newly elected leadership slashed food subsidies, a move that might be expected to raise infant mortality rates—but in fact the rates seem to have declined from the 1974 high. By the late seventies, infant mortality had again reached the level of the late sixties, and seemed to have resumed its downward course. Apparently, whatever health costs might have been involved in reduced food subsidies were counteracted by the benefits of a healthier economy.[17]

The Soviet Union is perhaps the most well known example of a nation that has reversed its historical progress in reducing infant mortality. A detailed analysis of its experience illustrates the complexity of the interacting influences on mortality trends. Before the seventies, the Soviets were justifiably proud of their health care achievements, having experienced at the turn of the century some of the highest infant mortality rates in Europe. As late as 1910, the western provinces of Russia still had rates of about 214 per thousand. By 1971, however, infants died at scarcely more than a tenth the rate of 60 years earlier—23 per thousand births. Soviet journals proclaimed the triumph with statements such as this from a 1972 article: "Infant mortality is a sensitive barometer of the social, economic and medical well-being of a society. . . . An analysis of the trend in the infant mortality indicator . . . allows one once again to draw conclusions about the superiority of the socialist society and its health service."[18]

"By 1976, the Soviet infant mortality rate had risen by one-third over the previous five years."

By 1976, this argument was no longer prominent in the literature, for the Soviet infant mortality rate had risen by one-third over the previous five years. Although the Soviet Union stopped publishing official statistics on infant mortality in 1974, other sources permit estimates for later years to be made. The difference between the 1971 rate of 23 and the estimated rate in 1976 of 31 meant that 38,704 more babies died in 1976 than would have been the case if the rate had remained at the earlier level. Moreover, the measurement techniques used in the Soviet Union understate the real infant mortality rate by excluding very small or premature babies who die in the first week after birth. Adjusting reported rates upward to compensate for this deviation from standard statistical practice produces an infant mortality rate of 35.6 for 1976. Demographers Christopher Davis and Murray Feshbach, who have done a careful analysis of Soviet trends, conclude that the rate has continued to rise since 1976 and that by 1979 it was probably three times the rate in the United States.[19]

Soviet statisticians have argued that the rising rates in the early seventies merely reflect improved statistical methods that have compensated for underreporting of infant deaths in the past. Davis and Feshbach reject that argument for several reasons. They note that the rise was not confined to the more primitive parts of the country such as Soviet Central Asia, where underreporting might have presented a serious problem in the past. Also, statistical methods have been improving steadily since the twenties in the USSR, yet the rise in infant mortality appears suddenly in the seventies. Furthermore, a change of methodology might account for a one-time jump in reported mortality, but not for the steady, sustained increase observed during the last decade. Finally, the demographers conclude, "if the increase had been mainly a statistical phenomenon, the Soviet authorities would have been well aware of the fact, and demographers and medical analysts throughout the USSR would not be expressing so much concern about the trend."[20]

Because of the lack of detailed information, the reasons behind the rise in Soviet infant mortality are difficult to pin down. Growing

alcoholism and smoking among women are suspected contributors, but data are too scant to document the intensification of these problems in the seventies. Similarly, the average Soviet woman has six abortions in her lifetime, which means that some individuals must have many more; the effects of multiple abortions on subsequent births have yet to be assessed accurately. Ninety percent of adult women in the Soviet Union work outside the home, and they are commonly employed in heavy industry doing strenuous manual labor. They usually continue to work until the seventh month of pregnancy; the strain of heavy labor and of exposure to toxic substances at work may be taking a toll among their infants. But it cannot be proved that these potential hazards increased during the seventies as infant mortality went up; they may not, therefore, have contributed to the rise.[21]

There are, however, several risks for mothers and for young children that did intensify during the seventies, and that are very likely to have played a part in raising infant mortality. They fall into three main categories: resource problems, social problems, and medical problems. In the first area, the shortage of protein foods for both mothers and infants is significant. Meat shortages in the Soviet Union have been well-publicized. They may affect the nutrition of pregnant women, which in turn would affect the likelihood of delivering healthy babies. The protein shortage affects infants directly, as well. Meat-based products comprise only 1 percent of the output of the Soviet baby-food industry. Milk production suffers from the same constraints as meat production, and is even more germane to infant health. While breast-feeding declined in the Soviet Union over the last decade, the manufacture of nutritionally adequate substitutes for mothers' milk did not evolve quickly enough to fill the gap. Thus improper feeding has been implicated in several studies of infant mortality in the USSR.[22]

Rising rates of illegitimacy and divorce, along with the decline of the extended family, are among the social factors that have probably boosted the Soviet infant mortality rate. The first two act to increase the number of households headed by women alone—households that

suffer a strong economic disadvantage as well as excessive demands on the mother's time. And the decreasing likelihood that a baby will have a resident grandmother, aunt, or other adult at home during the day has pushed more infants into institutionalized care. The quality of many child-care institutions is considered low, and high rates of infectious disease among their charges have been documented.[23]

Demographers Davis and Feshbach point out two other contributors to higher mortality that intensified during the seventies. The Soviet Union was hit by repeated epidemics of influenza, which raised the death rate among adults and children alike. They also found evidence that environmental pollution was an increasingly important cause of both respiratory illness and birth defects. Other observers join these analysts in criticizing the Soviet health care system's capacity to respond to these and other threats to infant lives. Part of the problem is outmoded equipment and supply shortages; as the proportion of the Soviet budget allocated to medical care has declined, infant mortality has risen. Another part of the problem is attitudinal. Both prenatal and pediatric care are poorly used, allegedly because mothers are reluctant to expose themselves to the long waits, inconvenient hours, and poor standard of treatment that characterize the low tiers of the health care system.[24]

Economic, social, environmental, and medical factors all play a part in determining the direction of change in the infant mortality rate, and they in turn may reflect more general strains in a society. The Soviet Government's choice to emphasize heavy industry at the expense of agriculture and consumer products, to raise military spending relative to health care budgets, and to demand full economic participation from women without guaranteeing equal social status all rebound, ultimately, on the chances for survival of society's youngest members. Decisions about a country's development are often reflected in the setting of budgetary priorities. This is one of the mechanisms by which public policy translates into rising or falling infant mortality.

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Direct Causes of Infant Deaths

In privileged communities, the majority of children who die before they are a year old are born with the condition that kills them—physical immaturity, a congenital deformity, a genetic disease, or a birth injury. The children of deprivation have a large share of these problems too, but the impact of these handicaps is swamped by a tidal wave of malnutrition and infection. Ecuador and Sweden, both countries of about eight million people, probably lose a similar number of infants to congential anomalies. But in Sweden these losses account for a third of all infant deaths, whereas in Ecuador they represent only 1.5 percent of a much larger total.[25]

Malnutrition in the very young does not usually kill outright; rather it is an accessory to the crime, lowering resistance to infections and parasitic diseases that would not be life-threatening to a well-nourished child. The most comprehensive investigation of infant mortality ever conducted in the Western Hemisphere was carried out by the Pan American Health Organization (PAHO) in the late sixties and early seventies. Examining data on 35,000 infant deaths in 15 regions of North and South America, it found that undernutrition was associated with 34 percent of the deaths in the Latin American communities. Another third of the deaths were caused by immaturity, which is often a product of undernutrition in the mother. Thus in well over half the cases PAHO studied, lack of proper food played a part. However, fewer than 6 percent of these babies had actually starved to death or been born with so few nutritional reserves that they soon died. For most, the proximate cause of death was a bout of diarrhea, a case of measles, an attack of pneumonia, or some other disease for which malnutrition set the stage.[26]

Just as undernutrition prepares the way for infection, disease undermines the nutritional status of the child. A sick baby often loses its appetite, so that its food intake is reduced just when it needs more nutrients than usual to fight off illness. Gastrointestinal diseases, among the most common afflictions of infancy, interfere with the absorption of nutrients from food. And most infections cause the

"Malnutrition in the very young
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it is an accessory to the crime."

body to excrete more nitrogen than normal, which raises the need for dietary protein. For all these reasons, weight loss during illness is common. One community-health study showed that one-fourth of the children who contracted measles lost at least 5 percent of their total body weight as a result. The fatality rate from measles can be 400 to 500 times as high in malnourished children as in the well-fed.[27]

Children who are poorly fed to begin with may not have the chance to recover their nutritional losses from one bout of disease before they are struck with another. In Matlab, a rural district in Bangladesh that has been the subject of a long-term health project, researchers charted the health of 207 young children for one year. The infants they studied each suffered an average of five episodes of diarrhea and ten of respiratory infection during the year, as well as assorted infections of the skin, eyes, and ears. This observation is consistent with a similar report on a group of Guatemalan village children, who on average came down with some sort of illness once every three weeks during their first three years of life. For many infants in these circumstances, life is a brief downward spiral of weakening resistance. The PAHO study found that three out of five infant deaths from infectious diseases in the areas studied had malnutrition as an associated cause.[28] In Africa and the high-mortality parts of Asia, the proportion would probably be even higher, for food supplies there are even more precarious than in Latin America.

The most tragic aspect of these deaths is that most are demonstrably preventable. The experiences of Kerala, Sri Lanka, and China demonstrate that poverty per se need not produce high infant mortality rates. The infectious diseases that kill so many babies in the Third World—several kinds of diarrhea, tuberculosis, measles, tetanus, polio, diphtheria, whooping cough—kill hardly any in the rich industrial countries. Two demographers who analyzed the major causes of death in the Brazilian state capitals in 1970 concluded that 27 percent of the deaths from infectious and parasitic diseases could have been prevented by vaccination, and a further 52 percent by proper sanitation.[29]

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In areas with low infant mortality rates, the principal causes of death in the very young are congenital defects, traumas of the birth process itself, and difficulties associated with immaturity in the newborn. The mechanisms of these three have been less well understood than the workings of the malnutrition/infection complex, so preventive measures have been slower to arrive. But progress on all three fronts is being made. New diagnostic tools help parents avoid having children with severe birth defects. Where they are available, genetic counseling, ultrasonography, amniocentesis, and legal abortion have reduced the incidence of Tay-Sachs disease, Down's syndrome, spina bifida, and other conditions that may be life-threatening. The birth process itself continues to increase in medical sophistication, though some techniques such as electronic fetal monitoring and the increasing reliance on Cesarean section are controversial.

The best predictor of an infant's survival is its weight at birth. Low birth weight as a major cause of infant mortality is shared by developed and less developed areas; the World Health Organization estimates that approximately 22 million babies are born each year weighing less than 2,500 grams (5.5 pounds). The vast majority of these, 95 percent, are in developing countries, not only because 85 percent of all births take place there, but because the average incidence of low birth weight is three or four times higher there than in the industrial world. Furthermore, the nature of the problem differs between well-cared-for and deprived populations. There are two kinds of immaturity. One results from a baby being born prematurely, before its full nine months in the womb are complete. The other occurs when a full-term infant has not grown sufficiently during gestation. In the most developed countries, approximately two-thirds of the babies with low birth weight are premature. But in developing areas, pre-term babies account for only one-fifth of this vulnerable group; four out of five are small full-term babies.[30]

The importance of birth weight as a risk factor for infants can hardly be exaggerated. In the United States, these very small babies make up about 8 percent of all births, yet they account for 62 percent of all perinatal deaths (those that occur between the 28th week of gestation

"Low birth weight as a major cause of infant mortality is shared by developed and less developed areas."

and the end of the first week of life). Among low-mortality countries, differences in infant mortality rates can be accounted for largely by differences in the distribution of birth weights. Sweden has a lower infant mortality rate than the United States because fewer immature babies are born there, not because the Swedes save more of their vulnerable infants. The same explanation applies to different infant mortality rates within countries. For example, non-white American babies have almost twice as high a death rate as white infants: 22 versus 12 per thousand in 1977. Babies of equal weight, however, do equally well regardless of race. Dr. Myron Winick, professor of nutrition and pediatrics at Columbia University, explains: "Pound for pound, the poor baby does as well as the rich baby; black babies do as well as white babies. The difference in mortality can be entirely explained by the fact that babies from these disadvantaged groups weigh on the average half a pound less at birth than middle-class babies."[31]

Low birth weight appears to be one of the major biological mechanisms through which physical and social stresses operating in a society are expressed as elevated infant mortality rates. The critical intervening variable in this equation is the health of the mother. As with all the other direct causes of death in infancy, it is necessary to look behind the incidence of low birth weight and ask the right questions. What conditions in society are responsible for the undernutrition, infectious disease, congenital defects, and low birth weight that run roughshod over the very young?

Behind the Direct Causes: The Social Environment

Many infants die from preventable or curable conditions because they and their mothers get little or no medical care before, during, or after birth. Observers from New York to New Delhi have found that the outcome of pregnancy is directly related to the quantity and quality of prenatal care. By monitoring the condition of the mother and the developing fetus, trained observers can identify high-risk pregnancies

and recommend appropriate interventions when necessary. For millions of women in developing countries prenatal care is nonexistent, but the lack is not exclusively a Third World problem. One-quarter of the women whose babies are delivered at the largest public hospital in Washington, D.C. have had no prenatal care at all—which explains, in part, the city's high infant mortality rate compared with the rest of the country.[32]

The World Health Organization estimated in 1971 that "more than half the pregnant women in the world received neither trained antenatal supervision nor skilled help in labor."[33] Traditional birth attendants are legendary repositories of folk wisdom, but some of their customary practices are harmful to mother and child. Neonatal tetanus, which is a major killer of infants in some parts of the world, is commonly the result of unclean hands or instruments used during childbirth. Many infections are spread in this manner by midwives who do not know the connection between unseen germs and early deaths. In northern India, for example, it is common practice to cut the newborn's umbilical cord with a dirty razor or sickle, and to "treat" the naval with ashes, mud, or even dung. Teaching traditional birth attendants the basic principles of hygiene is an inexpensive way to reduce infant mortality in areas where there are few nurses or doctors.

Easier access to medical care appears to be one of the reasons that infant mortality today is usually lower in urban than in rural areas. Medical facilities, supplies, and personnel are concentrated in the cities of rich and poor countries alike, but the disparity is particularly acute in most of the poor countries. Zaire, for example, in 1977 had one doctor for every 4,045 people in its capital, Kinshasa. This is not a high ratio by Western standards, but it is good compared with typical ratios in the outlying provinces: one doctor per 22,314 people in Shaba and one per 52,434 in Kasai Occidental.[34]

The poor countries that have lowered infant mortality rates significantly are distinguished by the even distribution of health services throughout their populations. China's network of "barefoot doctors"

is perhaps the best known system of low-cost medical care with a strong emphasis on maternal and child health, but it is not unique. Kerala ranks only ninth among the states of India in its per capita health expenditures. Yet it manages to serve the largest number of patients relative to population of any state in the country. The clear benefits for mothers and babies are attested to by the fact that it has the lowest infant mortality rate in India. Chile has also substantially reduced infant mortality, from 100 per thousand in 1965 to less than 40 today, while extending basic health services throughout the country. By the late sixties, according to Dr. Giorgio Solimano, almost all Chilean children were being vaccinated, 85 percent of the births were supervised by medically qualified attendants, and more than a thousand clinics were serving rural as well as urban residents.[35]

The unmet health needs of the world's poor majority are vast. The 1980 World Development Report from the World Bank asserts that fewer than 10 percent of the children born each year in developing countries (excluding China) are vaccinated against the most common childhood diseases. And, according to Bruce Stokes, no more than half the couples in the world have access to family planning services that, by enabling women to avoid high-risk births, could lead to dramatic reductions in infant mortality. Millions of infant deaths from dehydration due to diarrhea could be avoided if health educators could reach parents with instructions on how to prepare simple, life-saving solutions of water, sugar, and salt for their sick children.[36]

Many people in rural areas lack health care because there simply are no facilities or trained people within reach. But for many others, both rural and urban, the lack is a function of low income. If health care is not provided as a social service to people at all income levels, children may die in the shadow of the most modern hospitals because their parents cannot pay for treatment. However, the impact of poverty on infant mortality goes far beyond the question of access to medical care, touching virtually every aspect of the infant's environment. If a strong public commitment to the fulfillment of basic needs is absent, poverty becomes an important determinant of infant mortality.

26 A 1972-73 study in Chile compared the post-neonatal death rates of children of white-collar and blue-collar workers. The post-neonatal period extends from an infant's 28th day to the end of the first year of life, the period during which congenital problems subside in relation to environmental influences on a baby's health. The study further separated "non-avoidable mortality" from "reducible mortality" in its analysis. In the first category, infant death rates for blue-collar and white-collar families were equal. But in the second there were dramatic differences. Compared with the white-collar children, lower-class infants were twice as likely to be killed accidentally, three to four times as likely to die from infections or respiratory diseases, and nearly six times as likely to starve to death. A similar study charted the occurrence of low birth weight according to income group in the Indian city of Hyderabad. Researchers discovered that 52 percent of the infants of low-income mothers were dangerously small versus 23 percent of the babies born to women in the lower-middle class.[37]

Income interacts with every one of the common causes of infant mortality except for genetic defects. Poor families often cannot provide their children with food of sufficient quantity and quality, with uncrowded and well-ventilated housing, with enough clean water to keep them healthy, or with medical help when they fall sick. Perhaps most significantly, it is the poor household whose members are least likely to be educated and therefore to understand the origins and the prevention of the kinds of sickness to which their children most often fall prey.

Many observers argue, in fact, that ignorance is a more deadly foe of young children than poverty is—though the two so often go together that it is difficult to separate their effects. But the evidence seems to support their contention. One of the main things besides low infant mortality that distinguishes Kerala in India, Sri Lanka, and China from other low-income areas is the extent of mass education, particularly of women. The female literacy rate in Kerala, for example, was 54 percent in 1977, at a time when the national average was 19 percent. In Sri Lanka, more than 44 percent of the adult women have

"Education enables a mother to meet the challenges of a hazardous environment more successfully."

completed primary school, and virtually everyone in the younger age-groups learns at least to read and write. In Pakistan and Bangladesh in the mid-seventies, by contrast, only about 10 percent of the girls finished primary school. The difference is reflected in their infant mortality rates of 142 and 139 respectively, compared with Sri Lanka's 42. On the other side of the coin are wealthy countries such as Libya and Gabon where illiteracy is still widespread and infant mortality, not surprisingly, remains high.[38]

There are now several studies from different parts of the world that demonstrate conclusively the link between a mother's education and her children's chances of survival. One of the pioneering investigations of the connection was carried out by Hugo Behm and his colleagues at the Latin American Demographic Center (CELADE). In studies of the socioeconomic context of infant and child mortality, the researchers found that maternal education showed the strongest correlation of any variable observed. (See Table 3.) It outweighed rural-urban variations, income differentials, and ethnic origin. In 11 countries studied, the mortality rate of children whose mothers had ten or more years of schooling was only one-third to one-fifth the rate of children whose mothers were illiterate.[39]

World Fertility Survey data from several Asian countries have supported the findings of the CELADE study. Again, maternal education was the social characteristic that had the closest relationship with infant mortality. The impact was particularly strong on post-neonatal mortality, suggesting that education enables a mother to meet the challenges of a hazardous environment more successfully. In Pakistan during the period 1969-73, unschooled women lost 142 infants for every thousand born, whereas women who had been educated through the primary level or above lost 100. In Indonesia the range was 93 for the illiterate compared with 62 for those who had at least completed primary school.[40]

The reason that fewer babies of better educated women die is not well understood. Hugo Behm and others have tended to regard women's level of schooling as an indicator of general living conditions,

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Table 3: Child's Probability of Dying Before Age Two According to Education of Mother, Selected Latin American Countries, 1966-70

Country	Total	Years of School				
		None	1-3	4-6	7-9	10 or More
		(deaths per thousand live births)				
Cuba*	41	46	45	34	29	*
Paraguay	75	104	80	61	45	27
Costa Rica	81	125	98	70	51	33
Colombia	88	126	95	63	42	32
Chile	91	131	108	92	66	46
Dominican Rep.	120	172	130	106	81	54
Ecuador	127	176	134	101	61	46
Honduras	140	171	129	99	60	35
El Salvador	145	158	142	111	58	30
Guatemala	149	169	135	85	58	44
Nicaragua	149	168	142	115	73	48
Peru**	169	207	136	102	77	70
Bolivia***	202	245	209	176	110	***

*Division of groups is no schooling, 1-5 years, 6, and 7 or more.
**Division is none to 2 years, 3-4, 5, 6-9, and 10 or more.
***Division is none, 1-3 years, 4-6, and 7 or more.
Source: Hugo Behm and Domingo A. Primante.

as a proxy measure rather than a factor in its own right. There is ample reason to believe, however, that this assumption underestimates the direct role that maternal education plays in reducing infant mortality. An excellent study of Nigerian data by Australian demographer J. C. Caldwell confirmed the expected differentials in infant mortality according to mother's education. Caldwell, however, also separated out the effects of other socio-economic factors—such as father's education and occupation, place of residence, maternal grandfather's occupation, family structure, and so forth—by examining the mother's level of education within each sub-category. In every case, her schooling was found to have a strong, indeed a predominant, independent effect.[41]

Professor Caldwell reasons that education has an important impact on maternal capability—on a mother's ability to do her job. It increases her skills, her knowledge, and her ability to deal with new ideas, especially those from outside her own culture. Better information about nutrition and hygiene can lead directly to prevention of some of the most common childhood diseases. An educated mother is also better able to judge the gravity of an illness, to understand the capabilities of modern medicine, and therefore to seek appropriate care for a sick child at the right time. She can see more clearly which traditional ways of caring for children are valuable and can be selective in applying them. She is, in other words, more likely to intervene effectively when problems with a baby's health arise, and more likely to prevent them from materializing in the first place.[42]

Given what is known about the association between female education and infant mortality, it is especially distressing to learn that 60 percent of all the illiterate people in the world are women, and that the absolute number of illiterate women in the world appears to be increasing. Currently in the low-income countries, 90 percent of the boys aged 6 to 11 are in primary school, but only 64 percent of the girls are. In another ten years or so, these girls will enter the childbearing years—and one in three of them will be desperately ill-equipped to keep her children alive and well.[43]

Discrimination against women in educational systems is a recipe for higher infant mortality—as are most other forms of discrimination against women. The relationship between maternal malnutrition and low birth weight has been established, and yet women, even when they are pregnant, continue to be underfed more commonly than men. Research has shown that it is not only malnutrition during pregnancy that impairs a woman's ability to deliver healthy babies. Chronic undernourishment in childhood leads to growth deficiencies that have an impact on reproductive health in later life.

A thorough investigation of food consumption in a rural area of Bangladesh showed that females were fed less, relative to their size, than males at all stages of life. Discrimination was most pronounced

against the very young and the elderly. Malnutrition is measured in two ways. Weight-for-height deficits reveal acute lack of calories, while height-for-age deficits show chronic food deprivation. Both types were much more prevalent among Bangalee girls than boys: almost three times as many girls as boys were severely malnourished. A research team in Guatemala, noting the health problems of infants born to women who had been underfed as children, observed that it would really take two generations of improved female nutrition to bring down the infant mortality rate.[44]

Children whose fathers are dead or absent have an additional strike against them. Their mothers bear the entire burden of child care as well as having sole responsibility for the family's economic welfare in most cases. Because women commonly earn much lower wages than men, the female-headed household is likely to be a poor household. The difficulties that confront these mothers are reflected in their children's health. Almost everywhere, children born out of wedlock are more likely to die in infancy than children of married couples. In Washington, D.C., the fact that 48 percent of all births in 1980 were illegitimate is thought to be one reason behind the city's high infant mortality rate. In Buenos Aires in 1973, the infant mortality rate among children whose mothers were legally married was 22 per thousand, while it was 42 per thousand among the children of single women and women in common-law marriages.[45]

The social environment that greets a child at birth exerts a powerful influence on the probability that it will live through infancy. The physical environment outside the womb presents certain dangers to the newborn, and whether these become life-threatening depends in large measure on how well the family and community can manage them. Increasing resources, skills, and stability at these levels can be expected to pay dividends in the form of reduced infant mortality.

Behind the Direct Causes: The Physical Environment

If lack of medical care, low income, ignorance, discrimination against women, and family dissolution are elements of the social environ-

"When a child is exclusively breast-fed, its exposure to contaminated foods and utensils is limited."

ment that interact to set the stage for the common killers of infants, the elements of the physical environment that contribute most to the same grim outcome are poor sanitation and water supply. The World Health Organization estimates that in 1980, 57 percent of the people in the developing countries (excluding China) lacked safe drinking water, and 75 percent did not have adequate sanitation.[46] Human excrement and polluted water are the vehicles for a host of intestinal infections and parasitic diseases, which are easily responsible for half the infant deaths that occur in the highest mortality areas.

Three Nigerian public health officials investigated the living conditions of a group of children who had been brought to a Lagos hospital with acute cases of malnutrition. Most were from the large slum areas of the city, and the low level of household and community hygiene was found to be a key factor in their poor health. After visits to the children's homes, the team reported:

> Sanitation was very poor. There was not a single water closet (flush toilet) in any of the houses visited. The pail system was used and the stench can be almost unbearable. A few had no lavatory at all. Stools were thrown in the bush around. Generally children's stools are commonly found around the houses. Leaves used for wrapping food, waste food products, rags, and even human and animal stools littered the surroundings and gutters.[47]

In such an environment an infant is constantly exposed to agents of infection, especially when the baby begins to crawl around and explore its surroundings. One of the very few protections available to these babies is the breast-feeding that most of them have during their first several months of life or longer. When a child is exclusively breast-fed, its exposure to contaminated foods and utensils is limited. Furthermore, a mother's milk contains antibodies that increase her child's resistance to infection. And being ideal from a nutritional standpoint, for the first few months of life breast milk protects the infant from malnutrition, which so commonly operates in partnership with diarrhea to undermine infant health.

32 It is understandable alarm, therefore, that greets an apparent tendency in some parts of the world to abandon breast-feeding at ever-earlier stages of a child's life. Innumerable studies show a clear association between artificial feeding and increased illness and death among the very young. More in dispute are the actual extent to which mothers are switching to artificial feeds and the reasons why. Large, long-term, well-designed studies of breast-feeding are practically non-existent, so researchers have been forced to rely on very small, possibly unrepresentative samples and on evidence pieced together from larger studies not specifically investigating breast-feeding. Even these, however, are highly suggestive.

The Pan American Health Organization study of infant mortality revealed that nutritional deficiency and gastrointestinal diseases were much more important causes of death among artificially fed infants than among the breast-fed. A survey carried out in Port Moresby, the capital of Papua New Guinea, found 69 percent of artificially fed infants were malnourished compared with 26 percent of the breast-fed. A group of Chilean mothers surveyed in 1969 and 1970 reported three times as many infant deaths among babies given bottles before the age of three months than among those who were solely breast-fed. The Chief of Pediatrics at a Philippine hospital dramatically re-organized hospital routines in an attempt to encourage new mothers to breast-feed, and found that at the end of two years breast-feeding was up 85 percent and infant mortality was down by more than 40 percent.[48]

While the protective effects of mothers' milk are most important to children who are under constant threat of malnutrition and infection, observations in affluent countries suggest that privileged children also benefit from breast-feeding. Doctors at the Queen Elizabeth Hospital for Children in London noticed that only two of the 608 children treated there for gastroenteritis were breast-fed, a rate of 0.3 percent, although the breast-feeding rate in the community served by the hospital was about 14 percent. Dr. Allan Cunningham, a pediatrician practicing in upstate New York, reports that during their first year of life bottle-fed infants were hospitalized three times more

frequently than breast-fed infants. Dr. Cunningham, contrasting post-neonatal mortality rates for breast-fed versus bottle-fed babies, concluded that in the United States today something like 5,000 infant deaths could be avoided annually if breast-feeding were universal.[49]

Fortunately, some national statistics have recently become available on the incidence of breast-feeding, so it is now possible to assess the extent of the practice more accurately than before. The most serious decline has been in the duration of breast-feeding rather than in its initiation. Traditional breast-feeding patterns are least disturbed in Africa and Asia, where almost all children are breast-fed at birth and continue nursing throughout the first year. In most Latin American countries, by contrast, 10 to 20 percent of infants never nurse at all, and 25 to 50 percent are completely weaned by the age of three months.[50]

In North America, initiation of breast-feeding dropped to very low levels in the postwar period, but has rebounded quite dramatically during the seventies; the number of months infants nurse, however, remains very low. At the lowest point, from 1971 through 1973, only one-quarter of the new mothers in the United States chose to nurse their infants at all; by 1979, just over half did so. In 1971, only 5.5 percent were still breast-feeding by the time their babies were five to six months old, a proportion that increased to 23 percent by 1979.[51] If this rate of gain continues, 60 percent of the babies born in 1981 will have been breast-fed for at least a short time—one factor that may have something to do with the continuing decline in the U.S. infant mortality rate.

Some mothers in the United States and other industrial countries have turned away from breast-feeding out of fear that their milk may be contaminated with residues of pesticides, heavy metals, or industrial chemicals. In the U.S. effort to ban the organic pesticide DDT, environmental groups asked "Is mother's milk fit for human consumption?" Since then, residues of DDT, lead, PCBs, and other chemicals have been found in human milk, but their effects on infant health are not yet well-understood.[52] Most information about them

comes from animal studies or from disasters affecting humans, both of which provide much cause for concern but little guidance in the decision about whether to breast-feed.

Concern over the effects of toxic substances and environmental pollutants on infant health is not limited to breast-feeding, however. A child's health at birth may be influenced by maternal exposure to elements that are capable of entering the fetus's system via the placenta. Subsequent development of the child can be affected by direct exposures. In Brazil, the heavily industrialized city of Cubatão is notorious for its air pollution. Its 50-square-mile area is deluged daily by 473 tons of carbon monoxide, 182 tons of sulfur dioxide, 148 tons of particulates, 41 tons of nitrogen oxide, and 31 tons of hydrocarbons from the surrounding steel and chemical plants. According to the city's health directors, one-third of the city's children die in infancy. Eight percent are born with birth defects—a rate three or four times the norm.[53]

Cubatão is an extreme case, but few infants today completely escape exposure to toxic substances, either in the womb or after birth. Low birth weight, growth retardation, and congenital defects have all been linked to particular exposures to toxics, but the little that is known is suggestive rather than conclusive. Certain pockets of population also experience abnormally high rates of infertility, spontaneous abortions, stillbirths, neonatal illness, and infant mortality. And environmental disasters like the mercury poisoning at Minamata Bay in Japan, the chemical explosion in Seveso, Italy, the rampant pollution of New York State's Love Canal area, and human consumption of PCB-contaminated cooking oil in Japan have increased the incidence of birth defects, spontaneous abortion, or stillbirth. Birth defects now cause between 15 and 35 percent of the infant deaths in advanced industrial countries. One-quarter of the abnormalities are genetic in origin and between 5 and 10 percent are the products of specific agents known to cause birth defects, including drugs, viruses, radiation, and chemicals. The causes of the remaining 65 to 70 percent are unknown, and may be the result of genetics, environmental factors, or some interaction between the two.[54]

"More than 20 mental and physical defects in newborn babies have been associated with drinking during pregnancy."

Young children and fetuses may be considerably more sensitive to pollutants than adults are. Because they are smaller and have higher rates of metabolism than adults, children get a higher dose of toxic substances in their surroundings per unit of body weight. Their immature detoxification and immune systems are less efficient than those of adults. And they are in a period of rapid growth and differentiation, especially of the central nervous system, so that environmental insults may have a disproportionate impact on their development.[55]

The toxic substances that contribute most to infant mortality are not, however, the products of industrial or agricultural pollution. They are substances deliberately ingested by parents: alcohol and tobacco. The first has been linked to a variety of congenital malformations and to low birth weight, while smoking has been tied to low birth weight and a heightened risk of respiratory illness. As smoking and drinking have become more acceptable behavior for women as well as men, the number of infants exposed to these toxic substances has grown. The Census Bureau study on infant mortality in the Soviet Union, for example, suggests that maternal alcoholism may be one factor responsible for rising infant death rates there.[56]

In the Biblical Book of Judges, the angel of the Lord appears to the wife of Manoah, soon to become the mother of Samson, and says: "Behold now you are barren and have borne no children, but you shall conceive and give birth to a son. Now therefore, be careful not to drink wine nor strong drink, nor eat any unclean thing." The result of ignoring most Biblical injunctions may be grave peril to the soul, but to ignore this one threatens a more immediate tragedy—a case of the sins of the mothers being visited upon the sons and daughters. More than 20 mental and physical defects in newborn babies have been associated with drinking during pregnancy, some of which are life-threatening to the child. Grouped under the label "Fetal Alcohol Syndrome," they include severely weakened muscles that can prevent a baby from breathing correctly, disturbed brain structure (involving especially the area of the brain that handles learning and memory), deficient growth of the brain, a poor sucking reflex

and other feeding difficulties, tremors, and a peculiar array of distinctive facial abnormalities. Heart defects occur in about 30 percent of children with Fetal Alcohol Syndrome.[57]

Low birth weight has been commonly observed among the children of heavy drinkers, as has reduced length and head circumference in newborns. One study reported that women who drank at least one ounce of pure alcohol per day—roughly equivalent to two standard drinks of hard liquor—in their eighth month of pregnancy delivered infants who weighed 160 grams less, on the average, than the children of lighter drinkers. Stillbirth rates are also higher for heavy drinkers: 25 per thousand versus 10 per thousand for light drinkers in one French study.[58] The many dangers associated with maternal drinking have only recently begun to be thoroughly investigated, but already alcohol emerges as a major avoidable cause of infant death and disability. This new knowledge is cause for great alarm, because alcohol consumption is so widespread and because negative effects on infants begin to show up at levels of consumption as low as two drinks per day—well within the limits of acceptable "social" drinking.

Some of the effects associated with alcohol consumption are aggravated when a pregnant woman both drinks and smokes cigarettes. In the French study of stillbirth rates, for example, women who drank heavily and smoked had 50 stillbirths per thousand deliveries—twice the rate experienced by heavy drinkers who did not smoke.[59] The effects of drinking and smoking on birth weight are difficult to separate in mothers who do both, but each has been shown independently to retard the growth of the fetus.

Women who smoke during pregnancy deliver babies who on average weigh about 200 grams less at birth than infants of nonsmoking mothers. And smokers give birth to twice as many babies whose birth weight falls below the critical 2,500-gram mark. Furthermore, observed deviation from normal birth weight is proportional to the number of cigarettes smoked. Spontaneous abortions, stillbirths, premature births, and fetal deaths have all been shown to occur more frequently in smokers than in nonsmokers. Several disorders of

pregnancy that are often fatal to infants are also found disproportionately in smokers. Poor positioning of the placenta in the womb and premature detachment of the placenta are two that can lead to premature birth and to dangerous complications during delivery. These conditions are between one-fourth and one-half again as common in cigarette users. A blood disorder known as Rh disease and malformations of the heart and other organs are additional risks to the infant whose mother smokes while pregnant.[60]

As if this grim catalogue were not enough, the negative effects of smoking on infant health continue to mount after a baby is delivered. Recent evidence from the U.S. Collaborative Perinatal Project has established that cigarette smoking is a risk factor for sudden infant death syndrome, or crib death, a mysterious ailment that kills one in every 400 babies born in the United States and similar proportions in other industrial countries. Respiratory illnesses are more common in babies who inhale the smoke from their parents' cigarettes: bronchitis and pneumonia occur twice as often as usual in the first year of life if parents smoke.[61]

Smoking rates in many industrial countries have declined in recent years, but they have often declined more slowly for women than for men. In the United States, the only population group in which smoking increased during the seventies was teenaged girls.[62] That young women should be developing this habit just as they approach their childbearing years is not an encouraging sign for future reductions in infant mortality.

Fertility and Infant Mortality: A Two-Way Street

The total number of children that a woman bears in her lifetime and the timing and spacing of her pregnancies have major impacts on each of her children's chances of survival. Indeed, among all the factors that influence infant mortality, fertility is one of the most important. Unlike other factors, however, the relation between fertility

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and mortality is a two-way street. In most populations, high fertility and high infant mortality go together, as do low fertility and low mortality. This association reveals nothing about a causal connection between the two, however. Population experts, public health officials, and others have put enormous effort into trying to decipher the exact nature of the relationship.

The effect of fertility on infant mortality has been a fairly easy one to demonstrate. Women who start childbearing while in their teens or prolong it past their mid-thirties increase the chance that their children will die in infancy. Pregnancy and childbirth are safest for both mother and child when the mother is in her twenties. The Pan American Health Organization study showed clearly the effect of maternal age on infant mortality in survey areas that ranged from the affluent to the deeply deprived. In California, for example, PAHO found that 26 of every thousand babies born to teenage mothers died, compared to only 15 per thousand of those whose mothers were between 25 and 29 years old. The rate crept up again for older women, to 18 per thousand among mothers over 35. In the El Salvador project, overall infant mortality rates were much higher yet they showed the same pattern: mothers aged 19 or less lost 120 babies out of every thousand, while mothers aged 25 to 29 lost only 73. The death rate for children born to women over 35 was 94 per thousand.[63]

The time elapsed between the birth of a child and the end of the previous pregnancy, known as the birth interval, is also a major influence on infant mortality. A woman's body needs time to recover from pregnancy, to rest bones and muscles and rebuild nutritional reserves. A 1958 study in the Punjab in India demonstrated that the risk of death in the first year for babies born less than two years after their closest sibling was 50 percent higher than that of children born two to four years later, and almost twice that of children born after an interval of four or more years.[64]

The interaction between maternal age and the number of children a woman has already borne is especially important in determining

"The total number of children that a woman bears has a significant impact on their chances for survival."

infant mortality. A 20-year-old mother of two children has a greatly reduced possibility of producing a healthy baby the third time around. By definition, she cannot have had enough time between births to recover her childbearing resources, which are already limited by her youth. Similarly, a woman who has five births by the age of 24 will almost inevitably have difficulties, some of which may show up as infant mortality. PAHO's investigation in El Salvador showed this quite clearly. (See Table 4.) In cases where the age of the mother and the number of children she already had meant that the interval between births was particularly short, the infant mortality rate was three to five times higher than for other mothers in the same age-group.[65]

The El Salvador data illustrate another aspect of the link between high fertility and high infant mortality: independent of her age, the total number of children that a woman bears has a significant impact

Table 4: Infant Mortality Rate in El Salvador by Birth Order According to Maternal Age, 1968-70

	Age of Mother					
Order of Birth	Under 20	20-24	25-29	30-34	35 or more	Total
	(deaths per thousand live births)					
First	90	44	31	27	43	61
Second	162	69	40	24	18	72
Third	335	102	53	46	42	81
Fourth		196	68	37	45	87
Fifth		318	86	57	75	97
Sixth			204	74	79	127
Seventh			349	131	61	137
Eighth				292	110	220
Ninth or more					301	427
All Births	117	84	73	81	94	88

Source: Ruth Rice Puffer and Carlos V. Serrano.

on their chances for survival. In every country and every social class, risks to both mother and child escalate as the number of births passes three or four. The infant mortality rate rises sharply for the fifth, sixth, and later children.

The poorest families experience the most dramatic leaps in infant mortality as family size increases. Many poor women in the Third World have more than five children; in fact, it is the poor who tend to have least access to the means to space and limit their births. One-third of the mothers aged 40 to 50 in Kenya, for example, have had more than 10 children, and only 12 percent have had fewer than four. In Rwanda, one out of five of the babies who are fifth-born in their families dies before reaching its first birthday; two out of five of the infants with eight or more siblings die in infancy.[66]

There seem to be two major mechanisms responsible for the greater danger faced by infants with many older sisters or brothers: low birth weight and malnutrition. The former is a reflection of the nutritional drain on mothers who endure a virtually uninterrupted decade or two of pregnancy and lactation. The pregnant women, after all, is producing a child out of the raw materials of her own body. Toward the end of her reproductive life, if she has borne many children and especially if she has not been well-nourished herself, she has less to give. The food consumption of the members of large, poor families tends, not surprisingly, to be lower than that of smaller families at the same income level, even though the large family typically spends a higher proportion of its income on food. A study in the Democratic Republic of Congo demonstrated that a gap of a thousand calories per person per day separated families with four or fewer members from families with nine or more.[67] The youngest children in large families must face low consumption during infancy and early childhood, precisely when they are most vulnerable to illness and death caused or abetted by malnutrition.

In many countries, lower infant mortality rates can be attributed in part to a reduction in the number of high-risk births involving pregnancies too close together, women who have already had four or

more pregnancies, or mothers below the age of 20 or older than 30. The People's Republic of China, for example, has introduced firm policies that discourage early marriage and births outside of marriage, and has virtually eliminated very large families except among certain ethnic minorities. Both policies have undoubtedly contributed to lower infant mortality. Researchers at the University of North Carolina's School of Public Health have concluded that 27 percent of the reduction in the U.S. infant mortality rate between 1960 and 1972 can be explained by the fact that fewer women, especially young women, were having large numbers of children.[68]

In several low-income countries, including Sri Lanka, Thailand, Jamaica, and Colombia, the number of births to women older than 30 has declined by one-quarter or more since the mid-sixties. In Costa Rica, which has Central America's lowest infant mortality rate, births to women aged 30 to 35 declined more than half. World Fertility Survey data show that significant proportions of women in Third World countries who say they want more children are using contraception in order to space their pregnancies. The proportion runs as high as 40 percent in Colombia, and 30 percent in Turkey and Peru. Nicholas Wright estimated in 1974 that if all women in Thailand had their children between the ages of 20 and 34 and if none of them bore more than four children, infant mortality would fall by 27 percent—saving 60,000 lives per year.[69]

In looking at demographic patterns around the world, there is a clear coincidence between high fertility and high infant mortality on the one hand, and between low fertility and low infant mortality on the other. Because of this, and because fertility plays an active part in establishing high or low infant mortality, many observers have concluded that mortality must play a similar, causal role in determining fertility. According to this theory, parents who expect a high proportion of their children to die insure themselves against such losses by having more children than they would if they were confident that all had a good chance of surviving. By the same token, once they come to believe that virtually all children born will survive to adulthood, parents reduce their family size goals accordingly.

42 The evidence to support these assumptions, which together constitute the demographic transition theory, has been largely circumstantial. For example, a computer simulation using infant and adult death rates for India concluded that a typical Indian couple would need to have between six and seven children (an average of 6.3) in order to be 95 percent certain that one son would still be alive when the father reached the age of 65. The average number of births per couple in India is actually 6.5—a fact that seemed to be more than a coincidence to demographic-transition theorists.[70]

People concerned about population growth and public health have a high stake in the demographic transition theory, for it resolves what might seem to be a conflict between the objective of lowering population growth and that of improving public health. Obviously, if more infants survive into adulthood, population growth will increase. But the demographic transition theory holds out the hope that reductions in mortality will cause fertility to fall as well, so that the net sum of births and deaths will produce little or no change in population growth —or, in time, may actually cause it to decline. Furthermore, the same programs that reduce infant mortality could also be expected to reduce fertility eventually.

Closer investigation was undertaken to establish a causal connection between lower infant mortality and lower fertility. One link was readily apparent, in the form of lactation. Breast-feeding normally delays the return of ovulation and menstruation in a woman who has just given birth; obviously, if the baby dies the mother will stop breast-feeding, resume ovulation, and again be at the risk of pregnancy. Lactation, therefore, extends the interval between births. Researchers in Bangladesh compared the intervals between pregnancies of women who lost their babies in the first year with women whose children survived, and found a difference of 13 months. This figure is unusually high because breast-feeding in Bangladesh is virtually universal and prolonged—and because the nutritional condition of most Bangalee women is poor. In all population groups, however, breast-feeding extends the period of sterility after birth to some

"Historical studies
of the demographic transition
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degree. The longer birth intervals that result produce lower completed family size even among people who do not use contraception.[71]

Lower fertility as a result of breast-feeding is a biological—not a behavioral—response to lower infant mortality. But the demographic transition theory posits a change in people's behavior as a result of mortality changes. Attempts to uncover evidence of such changes have been disappointing. Historical studies of the demographic transition in Europe do not support the view that lower mortality led to lower fertility. In some countries, such as Belgium, the historical sequence was reversed: fertility fell before infant mortality declined. In the various regions of Germany, the order was as often one way as the other. In France, fertility and mortality declined roughly simultaneously. Contemporary studies in Latin America, Asia, and Africa have also been unable to prove a causal connection apart from the biological effect of lactation.[72]

Demographer Samuel Preston has outlined some of the reasons that fertility patterns might be imperfectly matched with mortality trends even if parents do attempt to replace infants who die or to insure against such losses. Couples may not have a "target" number of children firmly in mind against which they measure achieved family size, or their target number may be so high that they have as many children as they possibly can regardless of how many die. On the other hand, the loss of a child may be so traumatic an experience that parents decide not to have additional children who might expose them again to personal tragedy. Some couples may frame their desire for surviving children in terms of one sex only, so that several births may be required to replace the loss of one child. Most importantly, many couples have such imperfect control over their fertility that even if they have clear family-size goals firmly in mind they may not be capable of achieving them. Summarizing an extensive review of the research concerning the effect of mortality on fertility, Preston concluded "that only a small fraction of mortality variation at the family level seems to translate into fertility variation. The picture is not an attractive one for those who look for mortality reduction as a means

of reducing fertility through familial effects, let alone for those who advocate such measures as a means to reduce growth rates."[73]

The level of infant mortality remains one of the strongest predictors of fertility; knowledge of the one gives many hints about the other. But there is no room for complacency about overall growth rates on the grounds that whatever reduces mortality will also bring down fertility. If disastrous rates of population growth are to be avoided or brought down, efforts to eliminate the scourge of avoidable infant mortality must be matched by efforts to give parents the means to control their fertility, and by attempts to persuade them that it is in their own and their societies' best interests to do so.

Attacking the Roots of Infant Mortality

There is no quick fix for reducing infant mortality. The chances for survival of a society's youngest and most vulnerable members are determined by a complex set of mutually reinforcing conditions. These fall into two general categories: the state of the physical environment and the conditions that affect a family's ability to control their environment. The factors in the first category act *on* people, whereas those in the second act *through* people and require their active participation.

The dramatic gains in infant survival that took place in the industrial world around the turn of the century were largely the result of changes in the physical environment: improved water and sanitation, interruption of some major vectors of disease through vaccination or pest control, stable food supplies, control of some of the most egregious forms of pollution, and the development of medical science. The struggle to improve the physical environment continues, and still can pay huge dividends in lowering infant mortality rates. The World Bank estimates that it costs only about $5 to vaccinate a child against all the major infectious diseases that can be prevented this

way. Provision of adequate drinking water for all by the year 2000 is one of the major goals adopted by the members of the World Health Organization. Several countries, such as Egypt and Sri Lanka, subsidize basic foodstuffs—a policy that may wreak havoc with government budget outlays but that almost certainly has a positive impact on the health of infants.[74]

The threat to continued improvement in the physical conditions of life lies in a combination of misplaced priorities and resource constraints. It is hard, for example, to be optimistic about the future course of infant mortality in sub-Saharan Africa when per capita food production there has been falling steadily throughout the seventies.[75] The escalation of oil prices has forced a drastic restructuring of public expenditures in the oil-importing developing countries, with little room left to increase spending on public health and education. Perversely, past progress in reducing infant mortality has helped to exacerbate the problems created by the resource crunch, because lower infant mortality rates have not been accompanied by commensurate reductions in fertility.

The effects of the physical environment on a child's chance of survival depend heavily on its parents' economic and personal resources. Their ability to cope with the challenges of seeing an infant through the first year is determined not only by their income, but also by their knowledge of the resources available to them and their skills in using them. Because mothers are the chief caretakers during infancy, women's access to resources both tangible and intangible is particularly important to the welfare of the child.

Within many countries today there are conflicting influences on infant mortality, with some factors acting to bring down the rate and others acting to maintain or even increase it. In the United States, for example, some of the progress made in keeping babies of very low birth weight alive is cancelled out by an increasing proportion of births involving teenaged mothers. In Chile, improvements stemming from the extension of the medical service throughout the population are qualified by a deterioration in the food-purchasing power of the

working class. In Poland, an improved distribution of births by maternal age and number of previous pregnancies has resulted in lower infant mortality, but the net gain is lower than it might be because of other problems such as a deteriorating food supply and uncontrolled industrial pollution. In Sri Lanka, government commitment to health and education is fighting an uphill battle against public resource constraints.[76]

No society can afford to rest on its laurels because it has achieved a low mortality rate, for progress in this area is never irreversible. Public policies that seem to have little to do with infant survival may ultimately rebound upon it. In Britain, the Conservative Government's determination to reduce public outlays has forced the National Health Service to reduce spending on obstetric care, at a time when the national birth rate is going up. Similar budget cuts in the United States are aimed at programs such as the Supplemental Food Program for Women, Infants and Children—a program that was designed to help reduce infant mortality. Many governments have been required to cut public spending, including subsidies for basic foodstuffs, in order to qualify for credit from the International Monetary Fund. In the four years following an IMF loan to Peru in 1976, for example, the price of bread reportedly rose 1,000 percent, partly as a result of the removal of subsidies.[77] Such policies are likely to exert some upward pressure on the infant mortality rate, though with luck this may be counteracted by other, positive influences. As always, the multiplicity of factors that affect infant mortality will make it difficult to establish direct cause-and-effect relationships, but any government should be alert to the unintended consequences of economic policy.

The dominant direct causes of infant mortality in the world today do not yield easily to direct medical action. Malnutrition, diarrhea, and respiratory diseases cannot be controlled by vaccination or by eliminating a specific vector of infection. Rather they are functions of social and environmental conditions that must be addressed as part of a larger process of development. And "development" must, in this context, be carefully defined not just as a reflection of economic activity but as a measure of general well-being.

Davidson Gwatkin, in a review of recent trends in mortality in the Third World, observed that "during the 1960s, the most rapid improvements were recorded by countries noted for the egalitarian nature of their social and economic development (Chile and Costa Rica); the slowest in societies better known for the growth of their modern sectors." The experience of some of the egalitarian societies demonstrates that infant mortality levels can change rather quickly, and that the programs that bring the death rate down are not necessarily expensive ones. Such intangibles as health education, a restructuring of budgetary priorities, changes in sanitary practices, and more-even distribution of food resources can have enormous impact on mortality rates without a great expenditure. Kerala, for example, spends less per capita on education and health care than Punjab and has a calorie consumption only 50 percent that of the other state. But it spends its funds on primary education and basic health care, and food is distributed through public fair-price shops and an extensive school lunch program. The result: an infant mortality rate 50 percent lower than Punjab's.[78]

This is not to say that medical intervention has no part to play in reducing infant mortality. It most certainly does, especially once the foundation for good health has been laid in society at large. Setting appropriate priorities is as important in medical as in economic policy, however. Erik Eckholm recounts the case of a modern hospital in Cali, Colombia, that had excellent, modern facilities for the care of low-birth-weight babies. The low death rate among the "premature" babies in the hospital was a justifiable point of pride, comparable to that in North America, but 70 percent of the babies died within three weeks of leaving the hospital. Their home environments had not changed.[79] Water and sanitation, nutrition, mass immunization, and education in self-care should come first. Without them, much curative effort will be wasted.

Once broad public-health measures are largely in place, preventive care should focus on identifying those women who are most likely to encounter problems in pregnancy and childbirth. Maternal age and number of previous pregnancies, low income, and environmental dis-

advantages are among the conditions that can be recognized early in pregnancy, so that medical staff can be prepared to intercept threats to infant health before they materialize. Mass screening for such conditions as low weight gain, anemia, and high blood pressure can vastly increase the cost-effectiveness of specific interventions, be they nutritional supplements or special care during delivery, by helping to assure that they are applied only to those who really need them. Such a process presupposes the existence of a ubiquitous system of paramedical workers. China's barefoot doctors and Sri Lanka's extensive network of health-care volunteers provide two models of how such a system can be extended at relatively low cost.

The appropriate third stage of the endeavor to reduce infant mortality is curative in its approach, and involves the use of increasingly sophisticated medical techniques to save sick infants. A society can consider its resources well-directed if little of the effort involved in this stage goes to cure conditions that could have been prevented. Sophisticated curative measures may snatch infants back from the brink of death but leave the basic causes of infant mortality untouched. In Washington, D.C., the mayor assembled a blue-ribbon panel in 1979 to examine ways to reduce the city's high rate of infant mortality. It concentrated on medical issues: the adequacy of equipment available in public hospitals, the facilities for transporting sick babies to intensive care units, the quality of medical record-keeping, and so forth. Apparently little time was given to the more fundamental questions of why so many unmarried teenagers in the city give birth, why alcohol and drug abuse are such common problems in expectant mothers, or why so many pregnant women in an affluent city are poorly nourished.[80]

The stress on preventive rather than curative approaches to infant mortality not only is cost-effective; it also avoids a great deal of suffering among children and their parents. Furthermore, the impact of preventive measures goes beyond a single episode of disease, beyond the health of a single individual. The same actions that prevent infants from dying in the first year of life will also guarantee them a higher quality of life as they mature.

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